

PURULENT BRONCHITIS COMPLICATING MEASLES AND RUBELLA.

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THIS epidemic of exanthematous disease complicated by purulent infection of the bronchi attacked several hundred men belonging to a recent draft from New Zealand; 418 cases of measles and rubella occurred between January 1st and March 8th, 1918. In the large majority there was a copious frothy or muco-purulent bronchorrhoea, in 75 of them there was a severe purulent bronchitis, and of these 26 died. If we take into consideration only the definite cases of septicaemic bronchitis the mortality amounted to one-third of the men attacked, but, as practically all the cases showed signs of a much

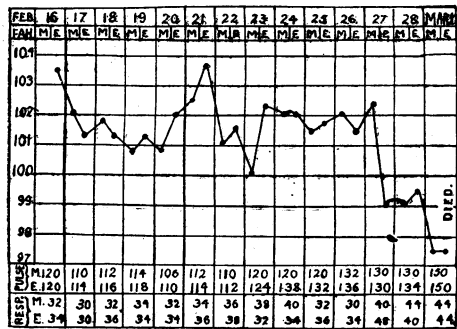


CHART 1.—Case 44. Rubella and bronchitis.

multiple infection, and, by doing so, to reduce the mortality to about 7 per cent.

We retain the name "purulent bronchitis" as bronchitis with purulent expectoration was common to all the cases, but the severe type consisted rather of a septicaemia accompanied by various lung lesions which were not constant but ranged from bronchial catarrh to bronchopneumonia, pleurisy, basal congestion, or lobar pneumonia. No one of these types could be said to prevail, but the serious cases which lived long enough passed through all these phases in succession, although they usually died before definite lobar pneumonia was well established.

There seems little doubt that the original infection occurred at an American port where the transports touched, as they had been free from infectious disease during the voyage, but measles and rubella broke out on board two of them just before arrival in England—that is, some fourteen days after leaving America. In the first five days after arrival at Sling Camp 77 cases developed, and thereafter the incidence was: Week ending January 19th, 60; January 26th, 125; February 2nd, 113; February 9th, 43; February 16th, 25.

During the same period 401 men suffering from febrile respiratory affections were admitted to the observation wards Sling Camp. These cases consisted largely of coryza or febricula, and 303 of them were described as "clinical influenza." It is noteworthy that none of these men developed purulent bronchitis, although most of them were respiratory cases, and had been living in the same

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huts as the measles and rubella cases. The complication of purulent bronchitis was limited strictly to cases of measles and rubella and to one case of scarlet fever.

Several organisms were recovered from the sputa and from the blood, and the virulence of the epidemic seems to be best explained by a symbiosis between one or more of these germs and the organisms of measles and rubella. If, as has been suggested in previous epidemics, the cause had been a symbiosis of the influenza bacillus with a pneumococcus or streptococcus, then we would certainly have expected to find some purulent bronchitis among 303 cases of clinical influenza which remained at Sling. But no single case of such a combination occurred.

Nor, again, did any purulent bronchitis arise among the 146 cases of measles and rubella occurring among British troops in the same district and at the same time, except in the case of a British motor driver who had been employed in transporting the New Zealand cases. Purulent bronchitis has only lately been clearly described and our knowledge of it is still in the mobile stage. It is undoubtedly much more widespread than is generally known. Thus, an officer (B.E.F.) died at Tidworth in February from bronchitis following some minor surgical intervention, and his lungs were found at the autopsy to show the same lesions as the cases dying from purulent bronchitis.

Further, three typical cases of purulent bronchitis complicating measles occurred in other New Zealand troops about the same time—one at Christchurch and two at Brockenhurst. These men had never associated with the draft at Sling, and they all recovered. It seems fairly certain, then, that purulent bronchitis is a condition in which there is

a definite symptom-complex resulting from a multiple pulmonary infection, but that the actual germs affecting this symbiosis are subject to variation. This does not necessarily lessen the stability of purulent bronchitis as a clinico-pathological entity, but seems rather to place it in the category of such conditions as haemolytic jaundice, pernicious anaemia, Banti's disease, typhoid and malignant neoplasm, in all of which a definite clinico-pathological condition is recognized as being of varied and multiple origin.

CLINICAL COURSE.

In most cases the onset was that of an ordinary cold, but in a few it was more sudden and accompanied by a slight rigor. In others there had been a bronchial or nasal catarrh for a week or longer, while in a few cases the men complained of having had a severe cough or sore throat for a month or so beforehand. Headache and pain behind the eyes were common features, and in a few cases there was profuse sweating.

Temperature.—The temperature was usually high at the outset, 103° or 104°, and in the lighter cases it dropped by lysis in a few days. In the severe cases it followed no definite course and presented the curve sometimes of continued fever (Chart 1), but more often of an irregularly remittent or even intermittent type (Chart 2). There was frequently an ante-mortem fall of temperature in the twenty-four or thirty-six hours before death (Chart 1), while some of the worst cases followed an almost apyretic course, and some reached the worst phase after the temperature had been down for several days (Chart 3).

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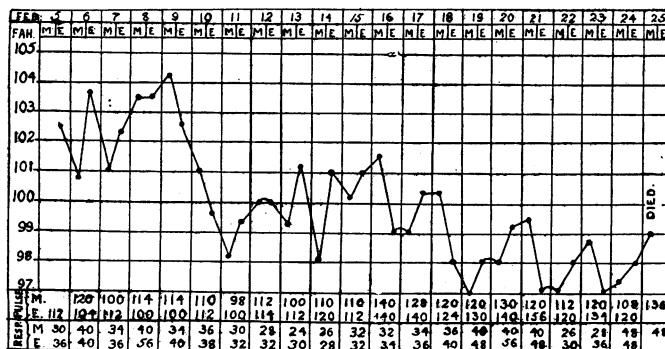


CHART 3.—Case 43. Rubella and bronchitis.

In no case could a falling temperature be taken as a guarantee of approaching safety.

Rash.—The eruption was morbilliform in 125 cases, in 290 it clearly resembled in appearance and distribution that of rubella, while in 3 it was scarlatiniform. In many of the cases Koplik's spots were present, and in 2 the rash became petechial. A marked feature was the frequent development of a secondary, and in one case a tertiary, rash. These later rashes developed about three or four days after the primary one had died down, and appeared mostly on the trunk and on the proximal portions of the limbs. They consisted chiefly of reddish maculae, and were probably of septic origin, as they could not be ascribed to any factor employed in treatment. Two patients developed measles and two others scarlet fever during convalescence from rubella.

Expectoration.—With very few exceptions the measles and rubella cases had purulent expectoration, but about 10 per cent. of these cases never became really ill. Usually the sputum became definitely purulent just about the time the rash came out or a day or two later. In four cases the original infection was so mild that the patients were sent on to the convalescent hospital at Perham Downs. Later they developed purulent bronchitis, which in these cases may be regarded as a secondary infection. This occurred respectively on the fifth, seventh, twelfth, and fourteenth days after the appearance of the rash. The last case, however, had been admitted with rubella and twelve days later developed measles which was followed by purulent bronchitis in two days, so that it is a little difficult to determine the incubation period. In more than 90 per cent. of the measles and rubella cases the sputum was copious, frothy, and later mucopurulent. In the more severe cases the sputum was definitely purulent from the outset, consisting of a tenacious, creamy pus, which was not offensive, and which stained the linen yellow. In the worst cases the sputum consisted of tough lumps of fibrino-purulent material, about the size and consistence of an American oyster, but they were yellow in colour, quite airless, and sank in water. They were expectorated with difficulty, and in the cases which recovered the sputum gradually became looser and freer, but persisted for many days after the temperature had fallen to normal. In the unfavourable cases expectoration ceased some twenty-four or thirty-six hours before death, and the bronchi became filled with pus. In a few cases the sputum was rusty, in a few streaked with blood, while one or two had definite haemoptysis or epistaxis.

Cough, Respirations, etc.—The cough was frequently hacking and persistent. Usually there was a marked tachypnoea from the outset without much distress, and this was increased by the slightest exertion, such as turning over in bed. Orthopnoea was rare, and most of the patients felt easier when the head was low. Painful respiration was not a prominent feature even when there was well marked pleurisy.

Pulse.—This was usually rapid from the outset, as is seen in the accompanying charts. The volume and tension were low, but the pulse was not definitely dicrotic. The heart showed early signs of fatigue by a weak short first sound at the apex, and later by failure of second sound at the base and some dilatation of the right side. Cupping was resorted to in some cases, but did not give marked relief. Even where the lung involvement was not extensive, the heart seemed to be affected in an extreme degree by the toxæmia.

Lividity.—One very marked feature was the intense degree of lividity. This came on in the severe cases before the heart was in difficulties, and affected the head, ears, face, and trunk, the face presenting a deep purple appearance as if the patient were on the point of choking, but there was no distress. Only two cases which presented this feature recovered.

Throat, etc.—In the severe cases there was usually a very dirty condition of the mouth and throat, and the tongue became dry, brown, and covered with sordes. A well-marked laryngitis causing dysphonia or complete aphonia was present in about 80 per cent. of the cases.

Abdomen.—Gastro-intestinal symptoms were uncommon, and vomiting was rarely troublesome.

Nervous System.—This was usually affected early and deeply, as shown by intense prostration, some degree of ataxia of the hands, and later by marked subultus

tendinum, muttering delirium or mental depression with suicidal tendency. One patient did commit suicide by cutting his throat. Incontinence of faeces and urine was a terminal symptom, while in some cases there was retention of urine at an earlier stage. The early and marked mental depression was undoubtedly a factor which contributed to the fatal issue in many cases.

Toxaemia.—Albuminuria was rare and when present was slight. The blood count showed no very marked peculiarities. The spleen was usually not definitely enlarged. As the condition was undoubtedly a septicæmic one, these points are rather surprising. A very definite mousy odour, such as one finds in typhus, was present in most of the fatal cases.

Complications and Sequelae.—Conjunctivitis occurred in some cases and in a few was purulent. Two cases developed otitis media and two had thrombosis affecting one leg.

Physical Signs.

The most striking feature of the physical examination in the early stages was the absence of signs suggesting a marked or extensive involvement of the lung tissue in patients who presented all the clinical features of a severe pneumonia. In the mild cases the breath sounds were harsh and were accompanied by some sharp or sonorous rhonchi and by a few medium crepitations at the base of the lungs. In the more severe cases the signs of bronchitis were more marked and passed into those of bronchopneumonia with patches of dullness on the posterior aspect, deficient or, less frequently, broncho-vesicular breathing, and usually some pleural friction.

Signs of pleural effusion were rare and empyema never supervened. Evidence of consolidation (at one or both bases, more often the right, and occasionally at one apex) was present in most of the fatal cases for a day or two before death, but in some these signs were absent or very slightly marked. Towards the end coarse bubbling râles could be heard all over both lungs.

TREATMENT.

In dealing with the treatment of a small number of cases such as this it is not possible to do more than record the facts noted, as following the different lines of treatment, and point out certain indications of success, which must be interpreted according to the faith of the individual. The difficulty of arriving at a definite conclusion is enhanced by the fact that the cases were admitted for treatment at various stages of the pulmonary complication, the date of admission being dependent on the appearance of a rash which was not always coincident with the onset of the pulmonary symptoms.

Drugs.

The use of drugs was confined to symptomatic treatment in the way of combating the great strain involved on the heart, oxygenating the lungs, and so aiding the reduced area of normal lung tissue in its functions, helping the drainage of the pus from the lungs by expectoration, and hindering the growth of pyogenic organisms in the lungs by local applications.

For this purpose heart stimulants such as brandy, strychnine, and digitalis, ammonium carbonate, oxygen varmed and alcoholized, stimulant expectorants, and antiseptic inhalations were tried. Of these, it is enough to say that brandy, strychnine, and digitalis had the effect expected of them, but none on the general course of the disease, and can merely be classed as useful adjuvants. The same may be said of the stimulant expectorant mixture. Oxygen was most disappointing; in only one or two cases did it seem to give even transitory relief to the cyanosis and distressed breathing. Whether the inhalation of antiseptic vapours had any effect it is impossible to say.

Vaccines.

Three different vaccines were used, and in view of the later bacteriological findings it must be noted that no one of these three included all the organisms which appear to be responsible for the clinical symptoms.

Vaccines Used.

A. A mixed stock vaccine, obtained from Captain Eagleton, R.A.M.C., bacteriologist at Sutton Veny, consisting of 1,250 million Pfeiffer's bacillus and 250 million Friedländer's bacillus per cubic centimetre. This vaccine had been prepared under

instructions from command head quarters in anticipation of possible outbreaks of purulent bronchitis.

B. A vaccine prepared from cultures obtained from the blood and pericardial fluid of cases in the epidemic under consideration, consisting of two preparations containing (a) *Streptococcus lanceolatus* and (b) *Streptococcus pyogenes longus*.

C. A vaccine prepared from the sputum of one case in this epidemic, consisting of two preparations, containing (a) *Staphylococcus aureus* and (b) pneumococcus, streptococcus, and a Gram-negative bacillus.

A number of cases were treated with vaccine A alone. Most of these had this vaccine within one or two days of the appearance of the measles rash, and the course of these cases was on the whole satisfactory.

Only six cases were treated with vaccine B alone, and results were not satisfactory, as it was tried rather late in the course of the disease and only in very serious cases.

Seven cases were treated with both vaccines A and B, with satisfactory results in five cases.

Three cases were treated with vaccine C only, and these may be eliminated as inconclusive, as in these one had his first dose of vaccine twenty-four hours before death on the seventh day of disease, when past all reasonable hope of recovery, the second had his first dose forty-eight hours before death on the fifth day of the disease, and although there was a marked fall of temperature, the general and pulmonary condition was such as to preclude recovery.

Dosage.

Vaccine A was given always in doses of 300 million Pfeiffer's and 60 million Freidländer's with an interval of four days before a second dose. There was never any untoward reaction.

Vaccine B was given in most cases in doses of 25 million *Streptococcus lanceolatus* and 25 million *Streptococcus pyogenes*, though in a few the dose was increased to 125 million *Streptococcus lanceolatus* and 33 million *Streptococcus pyogenes*. No untoward results were experienced from these doses.

Results.

- Of 36 cases treated with vaccine, 10 died, giving death-rate of 27 per cent.
- Of 25 cases untreated with vaccine, 16 died, giving death-rate of 64 per cent.
- Of 20 cases treated with vaccine A alone, 3 died, giving death-rate of 15 per cent.
- Of 6 cases treated with vaccine B alone, 4 died, giving death-rate of 66.6 per cent.
- Of 7 cases treated with vaccine A and B, 2 died, giving death-rate of 28.4 per cent.

Apart from statistical results we had the general impression that vaccine therapy had a good effect, whilst drug treatment was only of use as an assistant in combating special symptoms, that any treatment to be of use must be begun as early as possible, and that the recoveries after vaccine treatment had a more rapid convalescence than those untreated with vaccine. The good results of the vaccine were seen in an improved general condition rather than in the rapid subsidence of any special symptoms.

Ribadeau-Dumas and Brissaud have recently published (*Bulletin de la Société Médicale des Hôpitaux*, February 15th, 1918) an account of two cases of malignant measles occurring in Arab soldiers, and they mention casually that the sputum was purulent. The first case died, but the second was given intravenous injections of citrated blood from a measles patient who was convalescent, and he showed immediate improvement, and ultimately recovered. Several patients suffering from purulent bronchitis have since been treated with injections of polyvalent streptococcal serum at No. 3 New Zealand General Hospital, and all but one recovered.

General Treatment.

The cases were nursed in roomy, well-ventilated wards, and, although the weather was cold, it was considered that, in an obviously septic condition, fresh air was of more importance than warmth, and therefore the windows were always kept well open.

In a few cases with irritating and exhausting cough a steam tent was used.

Typical Cases Treated with Vaccine.

CASE 10. (Typical of eleven cases.)

On February 17th, 1918, the patient's condition was as follows: Looked very ill and was cyanosed; lungs full of wheezing rhonchi; sputum airless and purulent. On February 18th

condition was unchanged; vaccine given. On February 20th general condition was much better, and though the lung symptoms only cleared up slowly, there was no further anxiety about the case.

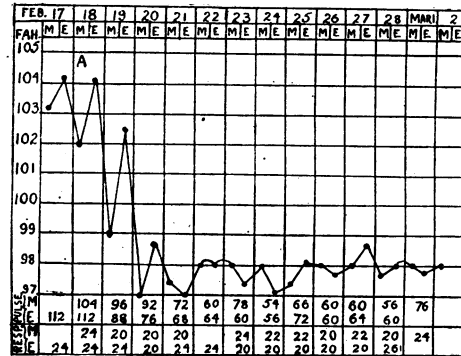


CHART 4.—Case 10. Measles and purulent bronchitis; recovery.
A, Vaccine A.

CASE 8. (Typical of four cases.)

In this case, on the day a dose of vaccine A was given there was bronchitis with purulent sputum and cyanosis. Prognosis was not good. After the vaccine there was a rapid fall in temperature, and though five days later there was return of pyrexia the general condition was much improved and never afterwards went back.

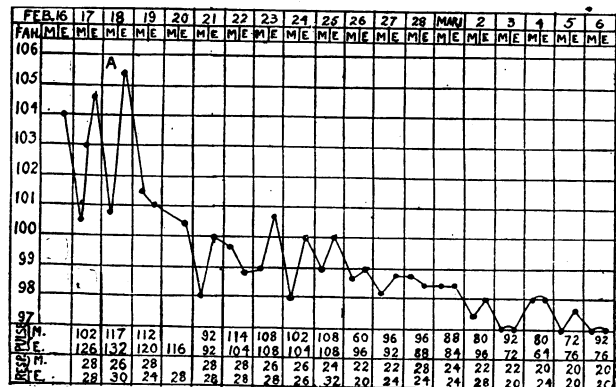


CHART 5.—Case 8. Measles and purulent bronchitis; recovery.
A, Vaccine A.

CASE 7. (Typical of three cases.)

On February 14th, 1918, the patient looked very ill; was very cyanotic; lungs full of scattered rhonchi; sputum purulent and nummular. On the 16th the patient was worse, and a dose of vaccine was given. On the 18th the patient was no better with the exception of a fall in temperature. On the 19th the cyanosis was less, though lung signs were more advanced with signs of commencing consolidation at right base. On February

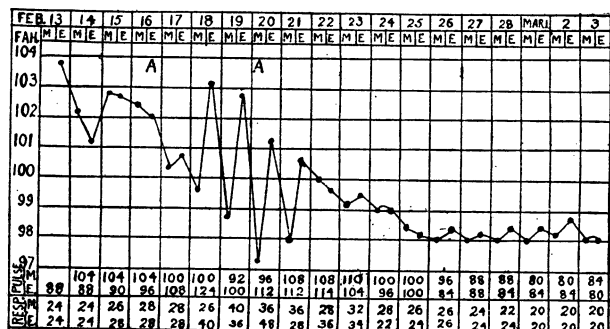


CHART 6.—Case 7. Measles and purulent bronchitis; recovery.
A, Vaccine A.

20th another dose of vaccine was given. On the 21st the temperature continued to fall, the lungs to clear up, and respiration to become easier, and by next day there was no further cause for anxiety.

CASE 27. (Typical of two cases.)

On February 16th, 1918, there were signs of purulent bronchitis; some cyanosis, rhonchi throughout lungs, and purulent sputum. February 17th, vaccine A given; general condition improved up to the 23rd, when the cyanosis became more marked and pulse was not good. February 24th, given a

dose of B vaccine containing 200 million *Streptococcus lanceolatus* and 25 million *S. pyogenes longus*. From February 25th onwards progress was rapid, the lungs clearing up rapidly from the grosser signs of disease.

BACTERIOLOGY AND PATHOLOGY.

In the investigation of the bacteriology of the condition the main sources of information were the sputum and

blood during life and the blood, spleen, and exudates *post mortem*. The results were as follows:

1. Sputum.—

Specimens of sputum from forty patients were examined, both by smears and cultures. The organisms most constantly present were streptococci, *Staphylococcus aureus*, and *B. influenzae*. Among other organisms less frequently met with were *Micrococcus catarrhalis*, *B. fusiformis*, diphtheria bacilli, pneumococcus, *Diplococcus crassus*, and *Staphylococcus albus*.

(a) *Streptococci*.—One or more varieties of the streptococcus were found present, both in smears and in cultures, in all cases examined, with the exception of two, from which the pneumococcus was isolated. Two streptococcal types were found to be of very constant occurrence—namely (1) *Streptococcus longus*, growing in small discrete colonies and producing active haemolysis on blood agar. (2) A streptococcus usually assuming a diplococoid or *brevis* form. This grew in flattened colonies, spreading at the margin and showing a tendency to coalesce into a greasy-looking greenish-grey film when densely sown. Its haemolytic action was small, and on blood medium it was found to be surrounded by a faint greenish halo.

(b) *Pneumococcus*.—In the two cases in which we failed to isolate streptococci from the sputum the pneumococcus was obtained in culture. In one of these cases, as mice were not available at the time, we were forced to rely upon the fermentation of inulin and the capsule stain of His in making the diagnosis. In the other case, examined during convalescence, smears of the sputum showed the presence of large numbers of Gram-positive capsulated lanceolate diplococci and numerous influenza bacilli. On culture media (tryptic agar + citrated human blood) a practically pure growth of these two organisms was obtained. A mouse which was inoculated with the mixed culture died in twenty-eight hours, and spleen smears showed the presence of Gram-positive capsulated lanceolate diplococci. Cultures from the spleen were made and the pneumococcus and a minute Gram-negative bacillus, probably *B. influenzae*, recovered. In several cases where preliminary cultural and microscopical features had been suggested, inoculation experiments proved the organism to be the streptococcus.

(c) *Staphylococci*.—*Staphylococcus aureus* was present in cultures from the majority of cases, often being one of the predominating organisms of the sputal flora. *S. albus* was less frequently found.

(d) *B. influenzae*.—This organism was present in smears in 24 of the 40 sputa examined and was grown in culture in 21 cases. In 8 cases it was present in smears, but failed to grow in culture, and in 5 cases where it was not found in smears it grew in cultures. It was therefore present either in smears or cultures, or both, in 29 of the 40 cases examined.

Summary of Results of Examination of Sputum.

Organism.	Frequency per 40 Cases.	Frequency per Cent.
<i>B. influenzae</i>	29	72.5
<i>Streptococcus</i>	38	95.0
<i>Pneumococcus</i>	2	5.0
<i>Staphylococcus aureus</i>	27	67.5

2. *Blood Cultures*.—Careful investigation of organisms isolated from the blood of several patients during life showed that streptococci were almost exclusively and constantly present. In only one case was the pneumococcus demonstrated with any degree of certainty. The streptococci isolated seemed to coincide, in their appearance on culture media, with the two forms described as

most uniformly occurring in the sputum.

3. Additional Investigations during Life.—

A number of throat swabs were examined, and from most of these the streptococcus and the *Staphylococcus aureus* grew abundantly on culture media. In one case the Klebs-Loeffler

bacillus was isolated. In two cases the streptococcus was found in the aural discharge from patients suffering from otitis media.

4. *Blood Counts*.—The blood count of patients suffering from this disease gave rather unexpected results. In place of the marked leucocytosis to be expected in the presence of a bacteraemia, the typical count seemed to lie between 8,000 and 12,000 per cubic millimetre. On the whole the differential count registered the septicæmia more definitely, though the relative polymorphonuclear leucocytosis appears below what might be reasonably expected.

Differential Count in Seven Cases.

Case.	Poly-morphs.	Mono-nuclears.	Large Lymphocytes.	Small Lymphocytes.	Remarks.
34	78.0	1.0	2.0	19.0	Died.
35	87.0	1.5	2.5	15.0	Died.
7	74.5	2.0	1.0	22.5	Recovered.
36	77.0	3.0	2.0	18.0	Recovered.
37	69.0	3.5	2.5	25.0	Recovered.
38	75.0	3.0	2.0	20.0	Recovered.
39	83.0	—	1.0	16.0	Died.

5. *Bacteriological Examination of Material obtained post mortem*.—Twelve cases were investigated *post mortem*. The cultures made from the bronchial discharges showed the same disparity as in the case of the sputa. The majority were typically streptococcal, though *Staphylococcus aureus* was present in several cases. In two cases only was *B. influenzae* isolated in pure culture, though smears of the secretions were sometimes suspicious. On the other hand, this organism could not be found either in the smears or cultures made soon after death in certain carefully studied cases. In addition to one or more of the organisms mentioned the bronchial secretion yielded a growth of the pneumococcus in three cases and of Gram-positive cocci in other three. Cultures from the blood, spleen, and pericardial fluid yielded uniformly a mixed growth of the two types of streptococci already described; sometimes one type appeared to predominate, sometimes the other. The heart blood and pericardial fluid in one case (No. 24), in addition to streptococcus and staphylococcus, yielded a Gram-positive bacillus and a Gram-positive coccus. Smears of the fibrinous exudate of Case 40 showed a capsulated diplococcus, streptococcus, and a Gram-positive coccus. Inulin-fermenting organisms of the pneumococcus type could be shown in two cases only. In two cases *Staphylococcus aureus* was encountered in the pericardial fluid.

INOCULATION EXPERIMENTS.

The study of the pathogenicity of the organisms associated with the disease has been mainly restricted to those isolated from the blood and organs at autopsy.

Streptococci from the spleen, pericardial fluid, and blood have been shown to be lethal to mice in moderate doses. In the case of both the streptococcal types already mentioned death occurred four to six days after injection. The organisms were recovered from the blood and spleen after death, and were found in abundance at the point of injection, where an accumulation of pus occurred.

On several occasions attempts were made to demonstrate the pneumococcus by injection into mice. Either results were negative or the suspicious organism proved to be streptococcus, except in one case, already referred to, where the pneumococcus and a minute Gram-negative bacillus were recovered from the spleen.

POST-MORTEM CONDITIONS.

As the conditions found *post mortem* varied considerably, it is difficult to describe any particular state as typical. It seems probable, however, that there is a definite sequence of pathological changes. This sequence of events is not apparently conditioned by the duration of the disease, and a fatal termination may ensue at any stage of the series. This was particularly noticeable in the case of the lungs, where more advanced changes were found in some cases of short duration than in others where death occurred after an illness lasting fourteen to twenty-one days.

Summary of Main Pathological Findings.

1. *Pleura*.—In the majority of cases a greater or lesser degree of fibrinous or sero-fibrinous pleurisy was present; in three cases the adhesions were very extensive. As a rule the accumulation of fluid was very small. The condition was usually more marked on the right side.

2. *Lungs and Bronchi*.—A constant feature was the presence of petechiae on the lung surface, most marked towards the base and along the interlobar fissures. As already mentioned, the conditions found varied considerably, but the differences were apparently a series of phases in the course of the disease, varying from typical purulent bronchitis with slight basal bronchopneumonia to complete lobar consolidation. In the advanced cases the following conditions were usually found in basifugal succession:

- (1) A basal consolidation.
- (2) A zone of slightly aerated lung intermediate between lobar pneumonia and bronchopneumonia.
- (3) A belt of bronchopneumonia. This was usually found in the lower portions of the upper lobes.
- (4) A belt in which minute elements of consolidation around the bronchi were closely dotted over the congested and oedematous lung.
- (5) An upper region of simple bronchitis.

The above must be qualified by the statement that in a few cases apical consolidation was present, and in most the anterior margin of the lungs and the middle lobe of the right lung were relatively unaffected. The state of the right lung was usually more advanced than that of the left. Patches of interstitial emphysema and small haematomata were encountered from time to time, and in one case multiple abscesses, about the size of half a crown, in cross section, were found in the consolidated lower lobes. The bronchi were in all cases acutely inflamed. The secretion varied considerably from case to case. In a few the bronchi contained a chocolate-coloured froth, interrupted here and there by plugs of yellow pus, but in the majority of cases the lumina of the bronchi were occupied by a yellow purulent discharge, which poured from the larger bronchi when they were severed. The bronchial glands were uniformly enlarged.

3. *Heart*.—In six of the fourteen cases examined there was marked sero-fibrinous pericarditis—the fluid either faintly turbid or flecked with fibrin. Fibrinous patches were most frequently found on the apex anteriorly and round the base. In several cases the right heart was dilated, and was usually gorged with clot.

4. *Spleen*.—In only four cases was the spleen found to be enlarged and pulpy. In the majority this organ was fairly normal in size and consistency, showing at most a tendency to become flattened. In view of the bacteriological findings already discussed, this is somewhat remarkable.

Summary of Results.

Organ.	Condition Present.	No. of Cases.	Per Cent.
Lungs ...	Purulent bronchitis and slight bronchopneumonia	3	21
	Purulent bronchitis and advanced bronchopneumonia	5	36
	Purulent bronchitis, bronchopneumonia, and lobar pneumonia	6	43
Pleura ...	Pleurisy ...	12	86
Pericardium ...	Pericarditis ...	6	43
Heart ...	Dilated ...	5	36
Aorta ...	Aortitis of ascending aorta ...	6	43
Spleen ...	Enlarged and pulpy ...	4	29
	Approximately normal ...	8	57
	Slightly fibrotic ...	2	14

Histology.

There is little to say regarding the morbid histology of the condition, for, apart from the lungs, there were but small signs of inflammatory change.

While sections cut from the more gravely affected lung tissues show the typical appearances of bronchopneumonia and lobar pneumonia some interest attaches to those which demonstrate the transition from a state of simple bronchitis to one in which the alveoli are involved.

This process commences with a marked infiltration of the peribronchiolar tissue by cells of the small round type, in a manner identical with that described by the Aldershot observers. The zone of inflammation extends to the surrounding tissue, and consolidation of the alveoli immediately adjacent to the pus-filled bronchioles ensues. The round cell infiltration is transient, and is soon replaced by one in which polymorphonuclear cells predominate. At this stage the microscopical picture is somewhat characteristic, showing numerous elementary consolidations about the bronchioles scattered over approximately normal lung tissues.

In a certain number of the cases examined *post mortem* there was little advance upon this condition; in others, however, the primary consolidations were found to extend and coalesce until their individuality was lost in bronchopneumonic patches.

Of other lesions of which microscopical evidence was obtained note may be made of a small amount of cloudy swelling in the kidney and a more or less marked congestion of the spleen, accompanied in some cases by small haemorrhages.

CONCLUDING REMARKS ON THE PATHOLOGY AND BACTERIOLOGY.

In view of the complex nature of the infection it is somewhat difficult to sift out the essential pathogens from those of subsidiary or individual importance.

The outstanding feature from this point of view is undoubtedly the almost universal association of measles and rubella with a streptococcal bronchitis and septicaemia. We have been much occupied by the question as to whether there was a direct symbiosis between the virus of measles and the streptococcus, enhancing the virulence of the latter and lowering the resistance of the host, or whether the symbiosis was an indirect one through the medium of the influenza bacillus. In the latter case the analogy with the Aldershot cases of purulent bronchitis described by Abrahams, Hallows, French, and Eyre would be very close. It is certain that the *Bacillus influenzae* has played an important rôle in this epidemic, but there is reason to believe that the measles attack in itself lowered the body resistance sufficiently to permit of a general invasion by the streptococcus. In any case, our observations tally in principle with those of the above workers, and are an interesting variant on the pneumococcal infection found by them.

It is interesting that, in a recent paper dealing with pulmonary complications following measles, Cumming, Spruit, and Lynch (*Journal of the American Medical Association*, April 13th, 1918, p. 1066) ascribed 94 per cent. of the fatalities to an infection by haemolytic streptococci. These authors make no reference to the influenza bacillus.

We have been frequently struck, both at Codford and at Tidworth, by the unusual preponderance of streptococcal, as contrasted with pneumococcal, infections in all types of pulmonary disease occurring amongst Australians and New Zealand troops on Salisbury Plain, and this has been especially noticeable in the cases of lobar pneumonia we have examined.

In many cases *Staphylococcus aureus*, although not one of the constant pathogens, must have contributed much to the acuteness of the pulmonary attack. As regards the pathology of the condition, two points are of special interest. In the first place the very varying gravity of the lung lesions found at autopsies shows that these lesions in themselves could not be held responsible for the fatality of the outbreak, which must without doubt be traced to the general toxic condition. In the second place, the exhaustion of all protective measures on the part of the body is typified by the feebleness of the leucocytosis and the absence of splenic and hepatic enlargement. Indeed it is almost to be wondered at that vaccine treatment elicited from the jaded patients the response which our charts exemplify, and it is unfortunate that time did not permit of opsonic comparisons being made.

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Postscriptum.—In a recent epidemic (October, 1918) of malignant influenza we find that respiratory symptoms are prominent, but only in a few cases is the sputum purulent. Moreover, several non-purulent cases present the features of profound toxæmia, collapse, and heliotrope cyanosis, which seems to suggest that purulent bronchitis is only one incident in a virulent mixed infection by Pfeiffer's bacillus and other organisms.

THE DIFFERENTIAL DIAGNOSIS OF SCARLET FEVER, MEASLES, AND RUBELLA.

BY

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It is of the greatest importance that these diseases should be distinguished from each other and from non-infectious diseases in the army, because (1) the quarantine periods vary, (2) the infectivity varies, and (3) the severity varies in different cases.

A definite method should be employed in the examination of cases so that nothing is missed, and the result of the examination should be accurately recorded for the benefit of subsequent observers. It is necessary that a good light be available, and that the throat, mouth, and skin be examined from above downwards. The temperature should be taken. Koplik's spots require a good light to be seen, and the mucous membrane opposite the lower molars should be turned out to the light by means of the forefinger of the hand outside, and the mouth should be open. The patient should be asked when he felt ill first, not when he reported sick; particulars of the onset should be obtained, especially where and when the rash appeared first. The incubation periods are useful to keep in mind.

The Onset.

Scarlet Fever.—Sore throat, shivering, sometimes vomiting, and the rash out within forty-eight hours, missing the face, and being seen on the neck, arms, and upper part of the body. Circumoral pallor is indefinite in adults, and I do not attach much importance to it.

Measles.—Headache, malaise, coryza the first day; Koplik's spots the second day, remaining the third, fourth, and fifth days. They should be seen two days before the rash comes out on the forehead, and still be seen the first two days of the rash; after this period they fade away. The rash comes out late on the third day or early on the fourth.

Rubella.—Little or no malaise, headache, slight fever, slight sore throat, the rash out from the second to the third day, but in a number of cases the appearance of the rash is the first indication that anything is wrong.

The Position of the Rash.

This is most important. These rashes have a definite distribution, a definite way of appearing, and a definite way of fading.

Scarlet Fever.—This rash does not usually appear on the face; it avoids the face as a rule. It is seen first on the neck, and spreads from above downwards. The feet are the last to show it. In the same way it fades, and the dorsum of the feet will show the rash distinctly when it is fading or has faded higher up. This is specially important when the rash is not a very heavy one. On the flexures of the joints the rash is likely to be more pronounced, or even haemorrhagic.

Measles.—The rash begins upon the forehead as a blotchy, livid discoloration, and spreads downwards. In twenty-four hours it is out on the legs, and is beginning to fade on the face by the time it is fully out on the feet and legs. It affects the whole body when it is fully out. It disappears from above downwards, and can be distinguished last on the feet.

Rubella.—This rash may be seen on the face first, but is evanescent. It also spreads from above downwards. It is necessary to look at the dorsum of the feet in all cases, because the rash may be seen there when it has faded from the body. This is essential to remember.

The Character of the Rash.

Scarlet Fever.—This rash is composed of fine red points on the background of an erythema; it may be discrete or confluent. When the latter, there is a bright general redness, and the skin may be swollen. The flexures may show in addition a haemorrhagic staining of the skin, not necessarily petechial. This is never found in rubella; the rash is more lasting, and may take several days to fade.

Measles.—This rash comes out as a papular rash, small red papules which can be felt projecting by the examining finger. Round a papule is a livid dark blotch. There may be several papules together, with one blotch around them. The rash is discrete at first, but rapidly the blotches become larger, more come out, and the general appearance becomes what is described as measly, or morbilliform, hence the name measles. These papules may be petechial, but the surrounding blotch is always there.

Rubella.—There are two types of rash—the scarlatini-form and the coarsely punctate with macules. It must be distinguished from scarlet fever, and the tests are: the evanescent character, the colour, and the fact that on some part of the body the rash will be found to be coarsely punctate and macular. In the scarlatini-form type the rash is not red but pink in colour, composed of pink points closely set together. This rash is usually found on the trunk, but if the feet are looked at, the rash will be found to be coarsely punctate and macular. In the ordinary type the rash is composed of large points, pink in colour, and mixed up with pink macules. The rash is discrete, but sometimes it is petechial as well. In all cases it is evanescent, and begins to fade in twenty-four hours, so it should be seen as soon as possible. It is last seen on the feet. The rash does not become deeper on the flexures. When associated with glandular enlargements and pink eye, there should be no difficulty in distinguishing it.

Early Symptoms.

Sore throat is a prominent feature in scarlet fever; coryza in measles; and slight headache, and slight watering of the eyes in rubella. Vomiting is not uncommon in measles and scarlet fever, and shivering in scarlet fever, while in rubella there may be no symptoms at all and the first thing noticeable is the rash.

Glandular Enlargements.

Enlarged glands below the ear are common in scarlet fever, and are associated with the sore throat. In measles, where there is a catarrhal throat and a measles rash on the mucous membranes, there are enlarged glands. In rubella the suboccipitals should always be examined; they are sometimes tender, and always easily palpable, but in some cases they are not enlarged, but the posterior cervical instead. The epitrochlear groin and axillary glands may be found enlarged. In other cases no glandular enlargements can be found, so that their absence does not exclude rubella, but when they are found it is valuable corroboration of other symptoms and physical signs.